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Perceived Responsibility for the Development of White Spot Lesions during Orthodontic Treatment

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This is to certify that the thesis prepared by Blake J Maxfield, D.D.S., entitled Perceived Responsibility for the Development of White Spot Lesions during Orthodontic Treatment has been approved by his committee as satisfactory completion of the thesis requirement for the degree of Master of Science in Dentistry.

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Perceived Responsibility for the Development of White Spot Lesions during Orthodontic Treatment

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Dentistry at Virginia Commonwealth University.

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Table of Contents

List of Tables

List of Figures

Abstract

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By Blake J. Maxfield, D.D.S.

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Dentistry at Virginia Commonwealth University.

Virginia Commonwealth University, 2009

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White spot lesions (WSLs) or decalcifications remain a common complication in orthodontic patients with poor oral hygiene. The purpose of this study was to compare attitudes regarding the development of WSLs among patients, parents, orthodontists and general dentists and improve prevention and treatment protocols through better communication.

A survey was developed to evaluate and compare the current opinions of orthodontic patients (n=315), parents (n=279), orthodontists (n=305) and general dentists (n=191) regarding the significance, prevention and treatment of WSLs.

All four groups indicated that WSLs did detract from the overall appearance of straight teeth. All four groups indicated that patients were the most responsible for the prevention of WSLs. All four groups indicated that the general dentist should be more responsible for the treatment of WSLs than the orthodontist. General dentists were

significantly more likely to indicate that the orthodontist was most responsible for the prevention of WSLs (P <0.005).

Longer version of Abstract

***Introduction*:** Despite the many advances to improve the practice of orthodontics, white spot lesions (WSLs) or decalcifications remain a common complication in patients with poor oral hygiene. The purpose of this study was to compare attitudes regarding the development of WSLs among patients, parents, orthodontists and general dentists and improve prevention and treatment protocols through better communication.

***Methods*:** A survey was developed to evaluate and compare the current opinions of orthodontic patients (n=315), parents (n=279), orthodontists (n=305) and general dentists (n=191) regarding the significance, prevention and treatment of WSLs.

***Results*:** All four groups (patients, parents, orthodontists and dentists), on average, indicated that WSLs did detract from the overall appearance of straight teeth. All four groups attributed primary responsibility for the prevention of WSLs to the patients themselves. All four groups indicated that the general dentist should be more responsible for the treatment of WSLs than the orthodontist. The patients indicated themselves as ultimately responsible for the prevention of WSLs significantly more often than did the other groups (P <0.0001). General dentists were significantly more likely to indicate that the orthodontist was most responsible for the prevention of WSLs (P <0.005). Differences existed in the perceived best protocol for treatment of severe WSLs among the dental professionals.

Conclusion: The patients, parents, orthodontists and general dentists participating in this study had similar perceptions regarding the significance, prevention and treatment of WSLs. All four groups indicated that patients were the most responsible for the prevention of WSLs. Communication among the patients, parents, orthodontists and general dentists needs to improve in order to decrease the incidence of WSLs in the orthodontic population.

Introduction

Despite the many advances to improve the practice of orthodontics, white spot lesions (WSLs) or decalcifications remain a common complication in patients with poor oral hygiene. Orthodontic practitioners strive to deliver the best orthodontic treatment to their patients with results that are functional, esthetic and stable. The debonding appointment is generally an exciting time for the patient, parents, orthodontist and staff. The presence of WSLs, however, can detract from an otherwise quality treatment result with nicely aligned arches, proper buccal segment interdigitation and optimal overbite and overjet. The orthodontist may feel as though they have failed the patient. Enamel decalcification is the most frequent nuisance complication with fixed appliance therapy.[1]

The white spot lesion is defined as "subsurface enamel porosity from carious demineralization" that presents itself as "a milky white opacity…when located on smooth surfaces."[2] Changes in light scattering of the decalcified, porous enamel are the reason for the white appearance. These WSLs rarely progress into significant cavitations and are generally not registered as caries requiring restorative treatment in the DMFT (Decayed, Missing due to caries, Filled Teeth) indices.[3] WSLs are largely esthetic concerns that can cause disappointment among patients, parents and dental professionals.

Orthodontic patients develop significantly more WSLs than non-orthodontic patients, and these WSLs may present esthetic problems years after treatment.[4] One study found that the incidence of at least one WSL in patients who underwent treatment with

fixed orthodontic appliances was 50%; this compares to only 24% in an untreated control group.[5] A recent study confirmed that about 50% of the patients receiving orthodontic treatment developed one or more WSL during treatment, compared to 11% in an untreated control sample.[6] Studies have shown that fixed orthodontic appliances induce a rapid increase in the amount of dental plaque and that such plaque has a lower pH than that in nonorthodontic subjects.[7,8] A rapid shift in the composition of the bacterial flora of the plaque occurs following the introduction of orthodontic appliances. The levels of acidogenic bacteria, such as S. *mutans*, become significantly elevated in orthodontic patients and the acid by-products produced in the presence of fermentable carbohydrates lower the pH.[9] As the pH drops below the threshold for remineralization, carious decalcification occurs. The first clinical evidence of this demineralization is visualized as a WSL. WSLs can form within four weeks, which is typically within the time frame between subsequent orthodontic appointments.[10] The presence of orthodontic attachments in the oral cavity makes the mechanical removal of plaque somewhat difficult.[10,11] In addition to the difficulty in removing accumulated plaque, an added lack of compliance in maintaining adequate oral hygiene can predispose orthodontic patients to white spot lesions.[12]

To prevent decalcification and formation of white spot lesions, a good oral hygiene regimen must be implemented, including proper tooth brushing with a fluoridated dentifrice.[13] Fluoride toothpaste is the basis for all caries prevention. Fluoride

concentrations below 0.1% should not be recommended for orthodontic patients.[3] For less compliant patients, the use of a fluoridated dentifrice alone is ineffective in preventing the development of carious lesions.[14] Orthodontic patients are therefore requested to use a fluoride mouth rinse (0.05% NaF) daily in addition to fluoride toothpaste.[3] Fluoride rinses have been shown to significantly reduce white spot lesions during orthodontic therapy.[14,15] Unfortunately these preventive measures depend on patient compliance. A study by Geiger et al.[15] reported that less than 15% of orthodontic patients rinsed daily as instructed. Poor patient compliance is a well-documented problem in the dental and medical literature. Wilson et al.[16] showed that only 16% of patients who received extensive periodontal therapy complied with the recommended maintenance schedules. It is understood that the health and well-being of patients depends on a collaborative effort involving both providers and patients.[17]

Since fixed orthodontic appliances introduce a high cariogenic challenge, there is a need for more continuous fluoride supplementation independent of patient cooperation.[3] Dental professionals have many available products that do not rely on the compliance of the patient to aid in the prevention of white spot lesions. The placement of fluoride varnishes is a feasible and safe method of fluoride application. Fluoride varnishes have been shown to decrease the amount of demineralization in orthodontic patients.[18,19] The use of glass ionomer cements (GIC) with fixed orthodontic appliances can provide a sustained fluoride release following bonding. Hallgren et al.[20] found elevated

concentrations of fluoride in the plaque samples collected adjacent to brackets bonded with GIC compared to plaque sampled from brackets bonded with composite. Enamel demineralization can significantly decrease with the use of resin modified glass ionomer (RMGI) instead of composite resin adhesives to bond brackets.[21] Because of recent improvements in the fluoride releasing capabilities and the shear bond strength of RMGIs,[22] it has been suggested that these adhesives should be more widely used in bonding orthodontic brackets in the future.[23] Products containing casein-phosphopeptide amorphous calcium-phosphate complexes (CPP-ACP) can be used to help inhibit enamel demineralization. MI Paste™ contains this active ingredient (CPP-ACP) that has been shown to decrease caries.[24] While these measures may help to lower the incidence of WSLs, WSLs may still develop in the absence of adequate oral hygiene.

White spot lesions are difficult to treat and are often permanent, regardless of the treatment approach. Re-examination of 40 individuals who had participated in a randomized controlled clinical study on the effect of a caries-preventive program[25] six years after debonding, showed that about 75% of the small WSLs had regressed during that period. Twenty-five percent of the most severe lesions remained visible on the surfaces.[3] Patients respond differently to the presence of WSLs, thus the recommended course of treatment will likely need to be unique to each patient. Treatment of WSLs at the onset should begin with the most conservative approaches.[13] Many clinicians often consider the application of topical fluoride to the WSL as the first step in treatment.[26]

Bishara,[13] Ogaard[27] and Wilmot[28] do not advocate the application of high concentrations of fluoride to WSLs due to an undesirable esthetic effect. High concentrations of fluoride react mainly on the outer surface of the lesion causing arrested development.[27,29] These arrested lesions will persist lifelong, exhibiting a white color as in WSLs, or they may become yellowish or dark brown in color due to exogenous uptake of stains.[3] Bishara et al.[13] suggest allowing for a slower calcium and fluoride penetration of the WSL from saliva or through the application of lower concentrations of fluorides. This approach may ultimately produce more esthetically favorable results. Such a treatment regimen may remineralize the mild WSL from the deeper parts of the lesion to the outer surface layers of the enamel, thus increasing the chances for a successful and more esthetic treatment result. More aggressive approaches are recommended if saliva and low concentrations of fluoride do not improve WSLs over time. Tooth whitening can camouflage the problem by whitening the surrounding enamel surfaces. Microabrasion has been shown to be an effective treatment approach for the cosmetic improvement of long-standing postorthodontic demineralized enamel lesions.[30] Another treatment option is MI Paste™ with Recaldent™ (CPP-ACP), which has been shown to remineralize subsurface lesions in human third molar enamel.[31] However, in many cases, none of these treatments are adequate to mask the lesions completely.

Ideally, patients and orthodontists work together to help prevent WSLs from developing during treatment. To decrease the current frequency of WSLs in the

orthodontic population, better communication between the patient and the dental professional may be needed. The purpose of this study was to gather information about attitudes toward development of WSLs that can improve communication among patients, parents, orthodontists and general dentists. Specifically, members of each of these groups were surveyed to assess their level of awareness and perceptions regarding development and treatment of WSLs. Answers were compared among groups to identify areas where differences in opinion occurred. Of particular interest was to which party primary responsibility for the development and treatment of WSLs was attributed by each group. The results would serve to improve prevention and treatment protocols regarding WSLs through better communication.

Materials and Methods

Four analogous surveys were distributed to four different groups of people who may be affected by the development of WSLs during orthodontic treatment: patients, parents, orthodontists and general dentists. The surveys were similar, but not identical, as questions were designed to target specifically the members of each group (See Appendix for surveys). Four identical questions were included among the surveys so that responses could be compared directly. These questions were: 1) How much do WSLs detract from the overall appearance of a completed orthodontic treatment result? 2) Who is responsible for preventing WSLs? 3) Who is most responsible for preventing WSLs? 4) Who should treat WSLs? Each survey provided a section for comments.

In order to improve the design and thereby increase the rate of response, the survey was pretested before implementation. Institutional Review Board approval was granted to conduct the study. The front page of each survey explained the purpose of the study and contained two color photographs of straight teeth. One photograph had no WSLs on the teeth following orthodontic treatment (Fig 1, A) and the other photograph had WSLs on the teeth following orthodontic treatment (Fig 1, B). These pictures were labeled to allow the participant to know what was being asked.

The American Association of Orthodontists (AAO) provided the names and addresses of all orthodontists, under the age of 60, practicing in Virginia, Maryland and North Carolina. The total list numbered 608 orthodontists. The AAO granted permission

to use the names and addresses for conducting this research project. Twenty-one of the addresses were not recognized by the post office as deliverable addresses. The surveys were mailed successfully to 587 orthodontists along with addressed postage-paid return envelopes. The return envelopes were coded to identify non-respondents. When the envelopes were received, they were matched to the code list and separated to maintain confidentiality of the answers submitted. A follow-up survey was sent to the orthodontists who did not return a completed questionnaire.

The American Dental Association (ADA) provided the names and addresses of 500 general dentists, under the age of 60, that were randomly chosen from Virginia, Maryland and North Carolina. The ADA granted permission to use the names and addresses for conducting this research project. Five addresses were not recognized by the post office as deliverable addresses. The surveys were mailed successfully to 495 general dentists along with addressed postage-paid return envelopes. The return envelopes were coded to identify non-respondents. When the envelopes were received, they were matched to the code list and separated to maintain confidentiality of the answers submitted. A follow-up survey was sent to the general dentists who did not return a completed questionnaire.

Seven different orthodontic offices (five in Virginia and two in North Carolina) voluntarily participated in this study. Each office was given 100 surveys. The receptionist at each office asked patients and parents if they would participate in the study. Fifty

surveys were to be completed by active orthodontic patients in full fixed appliances and 50 surveys were to be completed by parents of active orthodontic patients in each of the seven offices. The total number of surveys given to the patients and parents was 350 for each group. No individual identifying information was requested so answers were anonymous.

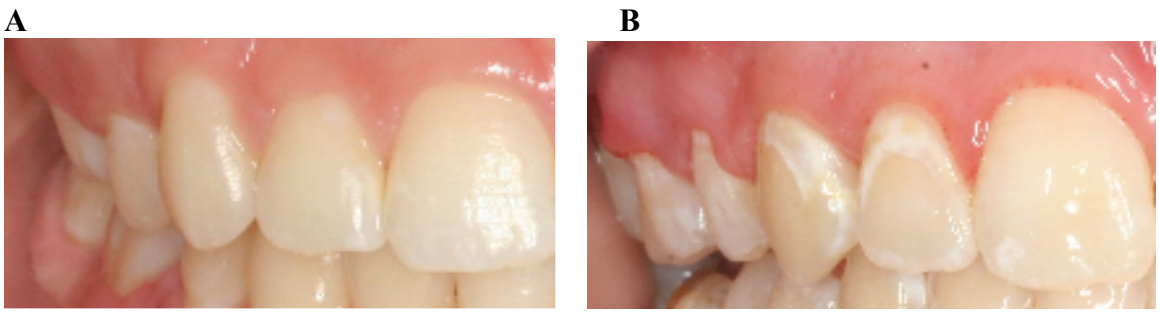

Fig 1. Post orthodontic treatment intraoral photographs of two different patients: **A,** teeth without white spot lesions; **B,** teeth with white spot lesions.

Chi-square analysis was used to determine differences in the responses to the questions among the four groups. JMP statistical software (SAS Institute, Cary NC) was used for all analyses. Patterns in the differences were identified by large cell chi-square values.

Results

A total of 1,090 (61%) surveys were returned. These included responses from 305 orthodontists (52% return rate), 191 general dentists (39% return rate), 315 patients (90% return rate) and 279 parents (80% return rate). Seventy-six percent of the orthodontists, 77% of the general dentists, 40% of the patients and 41% of the parents who completed a survey were male. The median age of the patients who participated in this study was 15 (range 7-69).

Questions requiring only one response were omitted from the results if more than one response was given. Unanswered questions were also omitted. Overall, 269 out of 10,585 responses (2.5%) were discarded. When asked for the percentage of their patients who have white spots after orthodontic treatment, orthodontists and general dentists surveyed did not always give a single number. When a range of values was indicated (eg "10-20%"), the middle value was used in the calculation of the mean (eg 15%). When an upper limit was indicated (eg "<20%") then the value midrange from zero was used in the calculation of the mean (eg 10%). When a lower limit was indicated (eg ">50%") then the value midrange to 100 was used in the calculation of the mean (eg 75%).

Perceived significance of white spot lesions

One question in each survey assessed the extent to which each respondent perceived that white spot lesions detracted from the overall appearance of straight teeth.

Reference was made to the colored photographs on the cover page of the questionnaire (Fig 1). The results are shown in Table I. The responses were different depending upon the group surveyed ($P < 0.0001$). A larger percentage of orthodontists indicated that the WSLs made the teeth look "a lot worse" (60%) as compared to all other groups (approximately 48%). The percentage of patients and parents who indicated that WSLs made the teeth look "no worse" was higher than dental professionals (7% versus 1%). There was no difference between the groups in terms of the WSLs making the teeth look "a little worse." Each group indicated this response about 45% of the time.

Table I: Perceived significance of WSLs

Q: Once teeth are straightened with braces, how much do white spots make the straight teeth look worse? (Circle one)

Group	No worse	A little worse	A lot worse	Total
Patients	25 (8%)	140 (46%)	142 (46%)	307
Parents	17 (6%)	122 (45%)	134 (49%)	273
Orthodontists	2 (0%)	117 (40%)	175 (60%)	294
General Dentists	2 (1%)	95 (51%)	90 (48%)	187
Total	46 (4%)	474 (45%)	541 (51%)	1061

Responsibility for the prevention of white spot lesions

One question asked who the respondent perceived was responsible for the prevention of white spots. Within each group surveyed, the respondent could indicate any that applied from the following list: patient, parents, orthodontist and dentist. The results are shown in Table II. Nearly all respondents indicated that patients were responsible; only 57 of the 1080 did not. However, the percentage that indicated that the patient was

responsible was significantly different among the groups ($P < 0.005$). The orthodontists indicated that patients were responsible more often (98%) and parents indicated that patients were responsible less often (92%). The percentage that indicated that parents were responsible was also different among the four surveyed groups ($P < 0.0001$). Very few of the patients said their parents were responsible (17%) but more parents indicated that they were responsible (72%). A greater number of general dentists (85%) and orthodontists (90%) indicated that parents were responsible. The percentage that indicated that the orthodontist was responsible also varied by group ($P < 0.0001$). Only 31% of patients and 55% of parents thought that the orthodontist was responsible. Over 82% of general dentists and orthodontists indicated that orthodontists were responsible for prevention. Dental professionals (orthodontists and general dentists) responded differently than patients and parents regarding the responsibility of general dentists in preventing WSLs ($P < 0.0001$). Patients (29%) and parents (39%) indicated less often than orthodontists (64%) and general dentists (69%) that dentists were responsible for the prevention of WSLs.

Table II: Responsibility for the prevention of WSLs

Q: Who do you think is responsible for the **prevention** of white spots in children/adolescents from braces? (Circle all that apply)*

Group	Patient	Parents	Orthodontist	Dentist	Total
Patients	291 (94%)	54 (17%)	97 (31%)	89 (29%)	311
Parents	251 (92%)	197 (72%)	150 (55%)	106 (39%)	274
Orthodontists	299 (98%)	275 (90%)	262 (86%)	194 (64%)	304
General Dentists	182 (95%)	162 (85%)	157 (82%)	132 (69%)	191
Total	1023 (95%)	688 (64%)	666 (62%)	521 (48%)	1080

* Those surveyed were instructed to check "all that apply," so the percentages do not sum to 100.

Most Responsible for the prevention of white spot lesions

One question asked for the single person most responsible for the prevention of WSLs. The results are shown in Table III. Overall, the patient was most commonly indicated as the single most responsible individual (at least 66%), but the responses varied by group ($P < 0.0001$). Patients indicated themselves as most responsible significantly more often than the other groups ($P < 0.0001$). Patients indicated themselves as most responsible 87% of the time (264/302) whereas all other groups indicated this a lower percentage of the time (524/705; 74%). General dentists indicated patients as most responsible significantly less often than the other groups ($P < 0.0001$). General dentists indicated that patients were the most responsible 66% of the time (118/180) whereas all other groups indicated this a higher percentage of the time (670/827; 81%). Patients indicated that their parents were the most responsible significantly less often than the

other groups (P <0.0001). Patients indicated that their parents were the most responsible 2% of the time (5/302) whereas all other groups indicated this a higher percentage of the time (100/705; 14%). The general dentists indicated that the orthodontist was most responsible for the prevention of WSLs significantly more often than the other groups (P <0.005). They indicated that the orthodontist was most responsible 17% of the time (31/180) whereas all other groups indicated this a lower percentage of the time (74/828; 9%). Orthodontists indicated themselves as most responsible significantly less often than the other groups (P <0.05). Orthodontists indicated themselves as most responsible 7% of the time (21/287) whereas all other groups indicated the orthodontist as being ultimately responsible a higher percentage of the time (84/720; 12%). Only nine respondents indicated that dentists were the most responsible and the frequency of this response was not different among the groups surveyed.

Table III: Most responsible for the prevention of WSLs

Q: Who do you think is **MOST** responsible for the **prevention** of white spots in children/adolescents from braces? (Circle one)

Group	Patient	Parents	Orthodontist	Dentist	Total
Patients	264 (87%)	5 (2%)	28 (9%)	5 (2%)	302
Parents	183 (77%)	27 (11%)	25 (11%)	3 (1%)	238
Orthodontists	223 (78%)	42 (15%)	21 (7%)	1 (0%)	287
General Dentists	118 (66%)	31 (17%)	31 (17%)	0 (0%)	180
Total	788 (78%)	105 (10%)	105 (10%)	9 (1%)	1007

Treatment of white spot lesions

One question asked who was responsible for the treatment of WSLs: the orthodontist or the general dentist. This question was asked slightly differently on the four surveys. On the patient and parent surveys, a third option was provided to allow them to indicate if they thought that the WSLs could not be removed at all. The results are shown in Table IV. All four groups indicated that general dentists were responsible for the treatment of WSLs more often than they indicated treatment by orthodontists. Only 13% of general dentists indicated that orthodontists were responsible for the treatment of WSLs, whereas 27% of orthodontists indicated themselves as responsible for the treatment of WSLs. In the non-dentist responders, 23% of patients and 16% of parents indicated that WSLs could not be removed from the teeth.

Table IV: Most responsible for the treatment of WSLs.

Q: Who should **treat** white spots on teeth from braces? (Circle one)

Group	Orthodontist	General Dentist	Can't remove WSLs	Total
Patients	69 (23%)	165 (55%)	68 (23%)	302
Parents	93 (37%)	120 (47%)	40 (16%)	253
Orthodontists	78 (27%)	214 (73%)		292
General Dentists	24 (13%)	165 (87%)		189
Total	264 (25%)	664 (64%)	108 (10%)	1036

Other questions were asked to each of the four groups. Full surveys and responses for each group are given in Tables V through VIII.

Table V. Responses to the survey questions by the patients

Questions for Patients	N	%
Current Age:		
Median = 15, range = 7-69		
Gender:		
Male	125	40
Female	190	60
How long have you been wearing braces?		
Less than 1 year	121	39
More than 1 year but less than 2 years	129	41
More than 2 years	59	19
No braces right now	5	2
Once teeth are straightened with braces, how much do white spots make the straight teeth look worse?		
No worse- white spots do not make teeth look worse	25	8
A little worse- white spots make teeth look a little worse	140	46
A lot worse- white spots make teeth look much worse	142	46
Why do you think people get white spots on their teeth from braces?*		
Not brushing and flossing often enough	205	66
Not brushing and flossing properly	187	60
Not using fluoride rinses	86	28
Some people are just prone to getting white spots from braces	16	5
Braces cause white spots	26	8
Did you get instruction on how to prevent white spots from braces?		
Yes	218	72
No	85	28
What do you do to take care of your teeth during the time when you have braces?*		
Brush	309	99
Floss	195	62
Fluoride rinse	162	52
Go to the general dentist for cleanings	183	58
Other	22	7
Who do you think is responsible for the **prevention** of white spots from braces?*		
Patient	291	94
Parents	54	17
Orthodontist	97	31
Dentist	89	29
Who do you think is **MOST** responsible for the **prevention** of white spots from braces?		
Patient	264	87
Parents	5	2
Orthodontist	28	9
Dentist	5	2
Who can **best** remove white spots on teeth from braces?		
Orthodontist	69	23
Dentist	165	55
White spots from braces cannot be removed from teeth	68	23

* "check all that apply items" percentages do not sum to 100

Table VI. Responses to the survey questions by the parents

Questions for Parents	N	%
Are you the parent of a child wearing braces?		
Yes	276	99
No (Return the survey if you do not have a child currently in braces)	3	1
Gender:		
Male	113	41
Female	162	59
Why do you think people get white spots on their teeth from braces?*		
Not brushing and flossing often enough	139	52
Not brushing and flossing properly	169	63
Not using fluoride rinses	50	19
Some people are just prone to getting white spots from braces	40	15
Braces cause white spots	31	12
Once teeth are straightened with braces, how much do white spots make the straight teeth look worse?		
No worse- white spots do not make teeth look worse	17	6
A little worse- white spots make teeth look a little worse	122	45
A lot worse- white spots make teeth look much worse	134	49
Do you think you and your child needed more instruction on white spots from braces?		
Yes	150	55
No	123	45
Are you worried your child will have white spots at the end of braces?		
Not at all worried	59	21
Somewhat worried	196	71
Very worried	20	7
If your child has white spots on his/her teeth after braces, would you still recommend braces to your friends in the future?		
Yes	221	81
No	6	2
Maybe	47	17
Who do you think is responsible for the **prevention** of white spots in children/adolescents from braces?*		
Patient	251	92
Parents	197	72
Orthodontist	150	55
Dentist	106	39
Who do you think is **MOST** responsible for the **prevention** of white spots in children/adolescents from braces?		
Patient	183	77
Parents	27	11
Orthodontist	25	11
Dentist	3	1
Who should **treat** white spots on teeth from braces?		
Orthodontist	93	37
Dentist	120	47
White spots from braces cannot be removed from teeth	40	16

* "check all that apply items" percentages do not sum to 100

Table VII. Responses to the survey questions by the orthodontists

Questions for Orthodontists	N	%
How long have you been practicing as an Orthodontist?		
0-10 years	91	30
10-20 years	95	31
20-30 years	82	27
More than 30 years	36	12
Gender		
Male	230	76
Female	74	24
Approximately what percentage of your patients has white spots after braces?		
Median = 10, range = 0, 90		
Once teeth are straightened with braces, how much do white spots make the straight teeth look worse?		
No worse- white spots do not make teeth look worse	2	1
A little worse- white spots make teeth look a little worse	118	40
A lot worse- white spots make teeth look much worse	175	59
In the last year, how often did you remove braces because patients had poor oral hygiene?		
Never	22	7
Rarely	169	56
Sometimes	104	35
Often	5	2
What precautions do you take to help prevent white spots from braces?*		
Encourage use of fluoride rinses	257	85
Provide fluoride rinses during treatment for free	112	37
Provide fluoride rinses for a fee	47	15
Place fluoride varnishes on teeth during treatment	108	36
Use MI paste	119	39
Use glass ionomer adhesive to bond brackets	81	27
Other _____	109	36
If you were to recommend fluoride to a patient with severe white spots, when do you recommend they use fluoride?		
Right after the debonding appointment	224	76
Wait a few months after the debonding appointment	33	11
Don't recommend fluoride for white spot lesions	38	13
Who do you think is responsible for the **prevention** of white spots in children/adolescents from braces?*		
Patient	300	99
Parents	276	91
Orthodontist	263	87
Dentist	195	64
Who do you think is **MOST** responsible for the **prevention** of white spots in children/adolescents from braces?		
Patient	224	78
Parents	42	15
Orthodontist	21	7
Dentist	1	0
After the braces are removed, who do you think is **MOST** responsible for the **treatment** of white spots?		
Orthodontist	79	27
Dentist	214	73
Assume you are seeing a patient who has severe white spots during their debonding appointment, what do you recommend for them to do immediately?*		
Wait a few months and allow the saliva to remineralize the white spots	56	18
In-office fluoride	54	18
Home fluoride rinses	162	53
MI paste	126	41
Refer to dentist for treatment	182	60
Other _____	31	10

* "check all that apply items" percentages do not sum to 100

Table VIII. Responses to the survey questions by the general dentists

Questions for General Dentists	N	%
How long have you been practicing as a General Dentist?		
0-10 years	37	19
10-20 years	57	30
20-30 years	70	37
More than 30 years	27	14
Gender:		
Male	146	77
Female	43	23
Approximately what percentage of your patients who receive orthodontic treatment has white spots after braces?		
Median = 20, range = <1, 100		
Once teeth are straightened with braces, how much do white spots make the straight teeth look worse?		
No worse- white spots do not make teeth look worse	2	1
A little worse- white spots make teeth look a little worse	95	51
A lot worse- white spots make teeth look much worse	90	48
How often in the last year have you treated white spots from braces?		
Never	12	6
Rarely	47	25
Sometimes	109	57
Often	22	12
How do you treat white spots from braces?*		
Home fluoride rinses	119	63
In-office fluoride	93	49
Tooth Whitening	91	48
Microabrasion	75	40
MI paste	57	30
Composite or porcelain veneers	108	57
Other _____	22	12
If you use in-office fluoride for severe white spots from braces, when do you recommend it?		
Immediately after the braces are removed	115	69
Wait a few months after the braces are removed	13	8
Do not use fluoride for white spot lesions	38	23
Who do you think is responsible for the **prevention** of white spots in children/adolescents from braces?*		
Patient	182	95
Parents	162	85
Orthodontist	157	82
Dentist	132	69
Who do you think is **MOST** responsible for the **prevention** of white spots in children/adolescents from braces?		
Patient	118	66
Parents	31	17
Orthodontist	31	17
Dentist		
After the braces are removed, who do you think is **MOST** responsible for the **treatment** of white spots?		
Orthodontist	24	13
Dentist	165	87
If your patient has multiple white spots at the end of orthodontic treatment, does this negatively affect your perception of the orthodontist?		
Yes	23	12
No	122	64
Sometimes	46	24

* "check all that apply items" percentages do not sum to 100

Discussion

Overall, the four different groups (patients, parents, orthodontists and general dentists) surveyed in this study had similar perceptions regarding the significance, prevention, and treatment of WSLs. All four groups, on average, indicated that WSLs did detract from the overall appearance of a finished orthodontic case. All four groups attributed primary responsibility for the prevention of WSLs to the patients themselves. All four groups indicated that the general dentist should be more responsible for the treatment of WSLs than the orthodontist.

Orthodontists are clearly concerned with the negative impact of WSLs on the esthetic appearance of teeth as evidenced by the large amount of research regarding white spot lesions in the literature. This study gathered information regarding the perceived significance of WSLs on the overall appearance of straight teeth as viewed by orthodontists and other groups involved. Overall, most participants in all groups agreed that WSLs made the appearance of teeth worse, but there were some significant differences between the groups. A higher percentage of orthodontists indicated that the WSLs made the teeth look “a lot worse” (60%) as compared to all other groups. A greater percentage of patients and parents (7%) indicated that WSLs did not adversely affect the appearance of the teeth as compared to the dental professionals (<1%). Although there was a difference between patients/parents and dental professionals, the actual percentage

of patients and parents who indicated that the WSLs did not detract from the esthetic appearance of the teeth was small.

The majority of orthodontic patients are adolescents and thus parents play an integral role in the prevention and management of WSLs. This study surveyed parents' perceptions regarding the significance of WSLs. Fifty-five percent of parents indicated that their child could have used more instruction on the prevention of WSLs during orthodontic treatment. Seventy-eight percent of parents with children undergoing orthodontic treatment were either worried or very worried that their child would develop WSLs during orthodontic treatment. Nineteen percent of parents indicated that they might not recommend braces to a friend if their child had WSLs following orthodontic treatment. This indicates that these parents perceive an overall negative outcome of orthodontics when WSLs form during treatment.

Orthodontists and general dentists responded to survey questions that assessed the perceived frequency with which they experience the formation of WSLs. Ninety-three percent of orthodontists indicated that they have removed braces early in the past year due to poor oral hygiene. Ninety-four percent of general dentists indicated that they have treated WSLs in the past year. Failure to diagnose, actively address and offer treatment for WSLs can be an ethical and legal issue for both orthodontists and general dentists.[32,33] When orthodontists and general dentists were asked to indicate the percentage of their patients that had white spots following orthodontic treatment, orthodontists indicated

10% (median) compared to 20% (median) as indicated by general dentists. A recent study[34] suggests that individuals recall negative experiences more easily and in greater detail than positive experiences. General dentists reported a higher percentage of patients with WSLs following braces than did the orthodontists, which could indicate that WSLs are triggering negative emotions for the general dentist leading to an increased remembrance. The general dentists were more likely than the other groups to indicate that the orthodontist was most responsible for the prevention of WSLs ($P < 0.005$). More than one-third of general dentists indicated that WSLs following orthodontic treatment could negatively affect their perception of the orthodontist.

When asked to identify who was responsible for the prevention of WSLs, the four groups indicated that all four parties were responsible, to some degree, for the prevention of WSLs. A medical study[35] documented that physicians and nurses perceive the patient to be ultimately responsible for lifestyle-related decisions dealing with certain diseases (i.e. dyslipidemia, high blood pressure, and Type 2 diabetes). In the current study, when asked to indicate the most responsible individual, a majority of all four groups attributed primary responsibility to the patient for the prevention of WSLs. Patients themselves were less likely to attribute responsibility to the other groups for the prevention of WSLs. The patients indicated themselves as ultimately responsible for the prevention of WSLs significantly more often than did the other groups ($P < 0.0001$). Only 17% of patients indicated that their parents were responsible for the prevention of WSLs. Parents

indicated themselves as responsible for the prevention of WSLs at a much higher rate (72%). Most of the patients in this study did not blame their parents for the consequences of their own inaction. Both orthodontists (91%) and general dentists (85%) indicated more often that parents shared some responsibility. The general dentists were less likely than the other groups to indicate that the patient was ultimately responsible for the prevention of WSLs ($P < 0.0001$).

The medical literature documents that a physician has a responsibility to inform the patient what is wrong, how it came about, how serious it is, and to present the different treatment options.[17] In this study, orthodontists expressed a strong sense of responsibility for the prevention of these lesions. Eighty-six percent of orthodontists indicated that they were responsible, to some degree, for the prevention of WSLs. However, orthodontists indicated themselves as most responsible for the prevention of WSLs significantly less often than did the other groups ($P < 0.05$). When orthodontists were asked what precautions they take to help prevent WSLs, 85% answered that they encourage the use of fluoride rinses, 37% provide fluoride rinses during treatment free of charge, 15% provide fluoride rinses for a fee, 36% place fluoride varnishes, 39% use MI Paste™ and 27% use glass ionomer adhesives to bond brackets.

All four groups indicated that the general dentist should be more responsible for the treatment of WSLs than the orthodontist. However, 27% of orthodontists versus 13% of general dentists indicated that orthodontists should treat WSLs. Sixty-nine percent of

the general dentists surveyed in this study indicated that they have treated WSLs (resulting from orthodontic treatment) in the past year "sometimes" or "often." General dentists have used several different methods to treat WSLs including: recommending home-fluoride rinses (63%), in-office fluoride (49%), whitening the teeth (48%), microabrasion (40%),[26] MI Paste™ (30%), and placing composite or porcelain veneers (57%). In this study, 23% of patients and 16% of parents thought that WSLs could not be removed. Without intervention, it is rare for WSLs to go away completely[4] and it is important for patients and parents to know that there are some treatment options available to improve or at least mask the lesions.

Patient and parent education regarding WSLs is necessary throughout orthodontic treatment. The responses given by patients and parents in this study indicated that they had received proper instruction regarding the process of WSL development. The majority of patients and parents indicated that WSL development occurred due to inadequate or improper brushing and flossing. Advice from dental professionals to maintain proper oral hygiene is necessary, but simply reminding patients may not be sufficient to decrease the incidence of WSLs. A meta-analysis of client-centered motivational interviewing found that strategies to increase the patient's intrinsic motivation so that change arises from within rather than being imposed from without outperformed traditional advice-giving strategies in 80% of studies.[36]

Certain people may be genetically more susceptible to the development of caries than other individuals.[37,38] It would seem logical, therefore, that certain people may be more susceptible to the development of WSLs around orthodontic brackets and bands, although this has never been demonstrated in the literature. Proper oral hygiene measures and additional fluoride supplementation may be more imperative in susceptible individuals. Some patients may show signs of decalcification before orthodontic appliances are placed. For these patients, Bishara et al.[13] recommend that the clinician should document the extent and severity of any WSL present through the use of intraoral photographs before orthodontic treatment begins.

Some clinicians consider the application of topical fluoride to the WSL as the first step in treatment,[26] whereas others[13,27,28] do not advocate the application of high concentrations of fluoride to WSLs. This study found a similar discrepancy in the opinions expressed by both the general dentists and the orthodontists. While 69% of general dentists recommended in-office fluoride treatment for severe WSLs right after the removal of fixed appliances, only 8% would wait a few months after the braces are removed and 23% do not use fluoride for white spot lesions. For orthodontists, 76% recommended fluoride for severe WSLs right after the removal of fixed appliances, 11% would wait a few months after the braces are removed and 13% do not recommend fluoride for white spot lesions. Ogaard[27] stated that “visible white spots on the facial surfaces developed during orthodontic therapy should therefore not be treated with

concentrated fluoride agents since this procedure will arrest the lesions and prevent complete repair." More research needs to be performed concerning the best protocol for remineralization of WSLs following orthodontic treatment and the results communicated to practitioners. Dental professionals are often faced with this scenario and the patients need to be informed of their best options for the long time health and esthetics of their teeth.

The common opinions expressed by patients, parents, orthodontists, and general dentists regarding the significance, etiology, and responsibility for the prevention and treatment of WSLs are encouraging for the future control of the incidence of WSLs due to orthodontic treatment. The current frequency of development of WSLs in orthodontic patients, however, indicates that there is a need for reassessment of the current protocol for the prevention of these lesions. Differences in responses among the groups could be helpful in identifying areas of communication needing greater emphasis. Many orthodontists seem to be following the recommendation of Ogaard[3] to provide a more "continuous fluoride supplementation independent of patient cooperation" due to the "higher cariogenic challenge" introduced by fixed orthodontic appliances. However, a substantial proportion of the patients in this study (28%) indicated that they did not recall receiving instruction on how to prevent WSL development. Motivating patients and training them to implement good oral hygiene habits may be more important than all of the advice and preventive measures combined. In this sense, parents and general dentists

may play an important role along with the orthodontist in helping patients to prevent the development of WSLs during orthodontic treatment.

Conclusion

The patients, parents, orthodontists and general dentists participating in this study all had similar perceptions regarding the significance, prevention and treatment of WSLs. All four groups, on average, indicated that WSLs did detract from the overall appearance of a finished orthodontic case. All four groups attributed primary responsibility for the prevention of WSLs to the patients themselves. All four groups indicated that the general dentist should be more responsible for the treatment of WSLs than the orthodontist. The patients indicated themselves as ultimately responsible for the prevention of WSLs significantly more often than did the other groups ($P < 0.0001$) and patients indicated that their parents were the most responsible significantly less often than did the other groups ($P < 0.0001$). The general dentists were significantly less likely than the other groups to indicate that the patient was ultimately responsible for the prevention of WSLs ($P < 0.0001$) and more likely to indicate that the orthodontist was most responsible ($P < 0.005$). Orthodontists indicated themselves as most responsible significantly less often than did the other groups ($P < 0.05$). Differences existed in the perceived best protocol for treatment of severe WSLs among the dental professionals. Communication among the patients, parents, orthodontists and general dentists needs to improve in order to decrease the incidence of WSLs in the orthodontic population.

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Appendix

Survey to Orthodontic Patients

1. Current Age: _____ years
2. Gender:
    a. Male
    b. Female
3. How long have you been wearing braces? (**Circle one**)
    a. Less than 1 year
    b. More than 1 year but less than 2 years
    c. More than 2 years
    d. No braces right now (please return survey if you don't have braces)
4. Once teeth are straightened with braces, how much do white spots make the straight teeth look worse? (See photos on other side)(**Circle one**)
    a. **No worse**- white spots do not make teeth look worse
    b. **A little worse**- white spots make teeth look a little worse
    c. **A lot worse**- white spots make teeth look much worse
5. Why do you think people get white spots on their teeth from braces? (**Circle all that apply**)
    a. Not brushing and flossing often enough
    b. Not brushing and flossing properly
    c. Not using fluoride rinses
    d. Some people are just prone to getting white spots from braces
    e. Braces cause white spots
6. Did you get instruction on how to prevent white spots from braces? (**Circle one**)
    a. Yes
    b. No
7. What do you do to take care of your teeth during the time when you have braces? (**Circle all that apply**)
    a. Brush
    b. Floss
    c. Fluoride rinse
    d. Go to the general dentist for cleanings
    e. Other _____
8. Who do you think is responsible for the **prevention** of white spots from braces? (**Circle all that apply)**
    a. Patient
    b. Parents
    c. Orthodontist
    d. Dentist
9. Who do you think is **MOST** responsible for the **prevention** of white spots from braces? (**Circle one)**
    a. Patient
    b. Parents
    c. Orthodontist
    d. Dentist
10. Who can **best** remove white spots on teeth from braces? (**Circle one**)
    a. Orthodontist
    b. Dentist
    c. White spots from braces cannot be removed from teeth

Comments:

Thank you for your participation

Survey to Parents of Orthodontic Patients

1. Are you the parent of a child wearing braces?
    a. Yes
    b. No (Return the survey if you do not have a child currently in braces)
2. Gender:
    a. Male
    b. Female
3. Why do you think people get white spots on their teeth from braces? (**Circle all that apply**)
    a. Not brushing and flossing often enough
    b. Not brushing and flossing properly
    c. Not using fluoride rinses
    d. Some people are just prone to getting white spots from braces
    e. Braces cause white spots
4. Once teeth are straightened with braces, how much do white spots make the straight teeth look worse? (See photos on other side) (**Circle one**)
    a. **No worse**- white spots do not make teeth look worse
    b. **A little worse**- white spots make teeth look a little worse
    c. **A lot worse**- white spots make teeth look much worse
5. Do you think you and your child needed more instruction on white spots from braces? (**Circle one**)
    a. Yes
    b. No
6. Are you worried your child will have white spots at the end of braces? (**Circle one**)
    a. Not at all worried
    b. Somewhat worried
    c. Very worried
7. If your child has white spots on his/her teeth after braces, would you still recommend braces to your friends in the future? (**Circle one)**
    a. Yes
    b. No
    c. Maybe
8. Who do you think is responsible for the **prevention** of white spots in children/adolescents from braces? (**Circle all that apply**)
    a. Patient
    b. Parents
    c. Orthodontist
    d. Dentist
9. Who do you think is **MOST** responsible for the **prevention** of white spots in children/adolescents from braces? (**Circle one**)
    a. Patient
    b. Parents
    c. Orthodontist
    d. Dentist
10. Who should **treat** white spots on teeth from braces? (**Circle one**)
    a. Orthodontist
    b. Dentist
    c. White spots from braces cannot be removed from teeth

Comments:

Thank you for your participation!

Survey to Orthodontists

1. How long have you been practicing as an Orthodontist? (**Circle one**)
    a. 0-10 years
    b. 10-20 years
    c. 20-30 years
    d. More than 30 years
2. Gender:
    a. Male
    b. Female
3. Approximately what percentage of your patients has white spots after braces?
    _____%
4. Once teeth are straightened with braces, how much do white spots make the straight teeth look worse? (See photos on other side) (**Circle one**)
    a. **No worse**- white spots do not make teeth look worse
    b. **A little worse**- white spots make teeth look a little worse
    c. **A lot worse**- white spots make teeth look much worse
5. In the last year, how often did you remove braces because patients had poor oral hygiene? (**Circle one**)
    a. Never
    b. Rarely
    c. Sometimes
    d. Often
6. What precautions do you take to help prevent white spots from braces? (**Circle all that apply**)
    a. Encourage use of fluoride rinses
    b. Provide fluoride rinses during treatment for free
    c. Provide fluoride rinses for a fee
    d. Place fluoride varnishes on teeth during treatment
    e. Use MI paste
    f. Use glass ionomer to bond brackets
    g. Other _____
7. If you were to recommend fluoride to a patient with severe white spots, when do you recommend they use fluoride? (**Circle one**)
    a. Right after the debonding appointment
    b. Wait a few months after the debonding appointment
    c. Don't recommend fluoride for white spot lesions
8. Who do you think is responsible for the **prevention** of white spots in children/adolescents from braces? (**Circle all that apply**)
    a. Patient
    b. Parents
    c. Orthodontist
    d. Dentist
9. Who do you think is **MOST** responsible for the **prevention** of white spots in children/adolescents from braces? (**Circle one**)
    a. Patient
    b. Parents
    c. Orthodontist
    d. Dentist
10. After the braces are removed, who do you think is **MOST** responsible for the **treatment** of white spots? (**Circle one**)
    a. Orthodontist
    b. Dentist
11. Assume you are seeing a patient who has severe white spots during their debonding appointment, what do you recommend for them to do immediately? (**Circle all that apply**)
    a. Wait a few months and allow the saliva to remineralize the white spots
    b. In-office fluoride
    c. Home fluoride rinses
    d. MI paste
    e. Refer to dentist for treatment
    f. Other _____

Comments:

Thank you for your participation!

Survey to General Dentists

1. How long have you been practicing as a General Dentist? (**Circle one**)
    a. 0-10 years
    b. 10-20 years
    c. 20-30 years
    d. More than 30 years
2. Gender:
    a. Male
    b. Female
3. Approximately what percentage of your patients who receive orthodontic treatment has white spots after braces? _____%
4. Once teeth are straightened with braces, how much do white spots make the straight teeth look worse? (See photos on other side) (**Circle one**)
    a. **No worse**- white spots do not make teeth look worse
    b. **A little worse**- white spots make teeth look a little worse
    c. **A lot worse**- white spots make teeth look much worse
5. How often in the last year have you treated white spots from braces? (**Circle one**)
    a. Never
    b. Rarely
    c. Sometimes
    d. Often
6. How do you treat white spots from braces? (**Circle all that apply**)
    a. Home fluoride rinses
    b. In-office fluoride
    c. Tooth Whitening
    d. Microabrasion
    e. MI paste
    f. Composite or porcelain veneers
    g. Other _____
7. If you use in-office fluoride for severe white spots from braces, when do you recommend it? (**Circle one**)
    a. Immediately after the braces are removed
    b. Wait a few months after the braces are removed
    c. Do not use fluoride for white spot lesions
8. Who do you think is responsible for the **prevention** of white spots in children/adolescents from braces? (**Circle all that apply**)
    a. Patient
    b. Parents
    c. Orthodontist
    d. Dentist
9. Who do you think is **MOST** responsible for the **prevention** of white spots in children/adolescents from braces? (**Circle one**)
    a. Patient
    b. Parents
    c. Orthodontist
    d. Dentist
10. After the braces are removed, who do you think is **MOST** responsible for the **treatment** of white spots? (**Circle one**)
    a. Orthodontist
    b. Dentist
11. If your patient has multiple white spots at the end of orthodontic treatment, does this negatively affect your perception of the orthodontist? (**Circle one**)
    a. Yes
    b. No
    c. Sometimes

Comments:

Thank you for your participation!

Vita

Dr. Blake J. Maxfield was born in Salt Lake City, Utah on June 1, 1979. He was raised in Utah and also lived in Brazil for two years following high school. He attended Brigham Young University for one year and then transferred to the University of Utah where he graduated with a Bachelor of Arts degree in 2004. He attended the Virginia Commonwealth University School of Dentistry where he earned a Doctor of Dental Surgery degree, Magna Cum Laude, in 2007. He was granted admission to the Department of Orthodontics at VCU where he received a Certificate in Orthodontics as well as a Master of Science in Dentistry in 2009. Dr. Blake J. Maxfield will enter the private practice of orthodontics in Salt Lake City, Utah.